THE USE OF REFRIGERATED STORAGE SPACE

by

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E. H. F.

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CHAPTER I

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I. INTRODUCTION

Modern transportation and marketing, including refrigerated cars, have made it possible for American homemakers to serve formerly perishable foods the year around. Home refrigerators are now considered a necessity in the standard of living of American homes. The refrigerated storage space which they provide has changed the types of foods which are served, especially during the winter months. How such space might best be designed for convenience is worthy of consideration.

Basing design on function or convenience in use, especially for a utilitarian storage space of the house, such as the refrigerator, is important. When considered from the standpoint of the infirm, the ill or the crippled, many of whom prepare their own meals and hence need to get and to return foods stored in the refrigerator many times each day, the importance of being able to see and to reach the foods easily becomes fairly obvious. In all homes meals are prepared during peak rush times when the family is hungry and in the kitchen while the meal is being prepared. When the storage of needed foods or containers is awkward or difficult, confusion is added to the situation. In some cases the location of frequently used foods has been closer to the floor than to the arm reach of the individuals who wish to use them for meal preparation. Storage space that is below eye level and difficult to see requires that the person using the space bend to search for the needed food.

As a preliminary to this investigation, letters of inquiry were written to seven of the leading refrigerator manufacturers regarding the basis they used for planning amounts of space for the various types of foods requiring refrigeration, for circulation of air, and for handling. Replies indicated that little or no basis has as yet been established. Some stated that the use of space by families differed so widely that it would be difficult to develop any such basis.

The amounts of refrigerated space needed by families may differ according to food purchasing facilities, food habits, family size, or age of the family members. Not only the total amount of space but also the amount for varying types of coldness and dimensions for varying areas need to be established. However the amounts of space provided need to be related to such differences. The relative convenience of spaces, which is dependent on frequency of use by the family members, also needs to be studied.

II. REVIEW OF LITERATURE

A review of literature indicates that few studies have been made in relation to the convenience of storage in refrigerators.

Maclinn, research specialist in food technology at Rutgers University, published The Rutgers Food Saver, which is concerned with the preservation of foods.[1] According to this publication the temperatures for refrigerated storage vary from ten degrees to fifty degrees Fahrenheit.

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[1]Maclinn, Walter A., Ph.D., The Rutgers Food Saver, New Brunswick, New Jersey: Rutgers University Press, 1952, p. 10.

The main part of most refrigerators maintains a temperature of approximately fifty degrees Fahrenheit while the difference in temperature next to the cooling coils and the point farthest away is seldom greater than three to four degrees but falls to ten degrees for quick freezing.

According to Worstrel and Praetz the recommended storage temperature for fresh meats is from thirty-eight to forty-two degrees Fahrenheit.[2]

Proper humidity is important in the length of time food may be stored. According to Worstrel and Praetz:

> If the relative humidity is too low, the air absorbs moisture from the stored products, causing wilting, shrinking and loss of color. If the humidity is too high, the growth of mold and bacteria is accelerated and meats become slimy.[3]

Circulation of air around foods is essential for long-term storage. Elaine Knowles states in Wise Use and Care of an Electric Refrigerator:

> Round or oval containers, even when crowded close together, allow better circulation of air in the refrigerator than do square cornered ones.[4]

For the storage of foods, Knowles suggests that food should not be stored in paper, for paper not only cuts down on the circulation of air but acts as an insulation around the food and lengthens the time required for cooling.

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[2]Worstrel, John F. and Praetz, John G., B.S., Household Electric Refrigeration, New York: McGraw-Hill Book Co., 1948, p. 375.

[3]Ibid.

[4]Knowles, Elaine, Wise Use and Care of An Electric Refrigerator, New York State College of Agriculture Bulletin 521, 1942, p. 9.

Home Management Specialists suggest that convenient storage is easy to see and easy to reach.[5, 6]

Apparently the refrigerator, its temperatures and its use, has not been studied to any great extent.

To the author's knowledge there has been no study on the amount, height, and frequency of use of refrigerated foods, all of which might logically be used as a basis for systematic arrangements of refrigerated space.

III. PURPOSE

The purpose of this study was to establish a basis for planning convenient storage arrangements and to recommend size of storage space divisions within the refrigerator.

Not only the total amount of space but also the amounts of space that require freezing, very cold, moist cold and the provision for tall or shallow kinds of storage space were to be established. The relative need for such spaces and therefore their priorities in planning for convenience of use were also to be determined.

The overall purpose was threefold. It was to determine:

1. The amounts of refrigerated space of varying temperatures required by foods stored by families. Since the amounts are dependent on the foods stored in the refrigerator, the quantity and kind were determined.

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[5]Gross, Irma H. and Crandall, Elizabeth W., Home Management In Theory and Practice. New York: F. S. Crofts and Co., 1947, p. 233.

[6]Fitzsimmons, Cleo, The Management of Family Resources. California: W. H. Freeman and Company.

2. The dimensions of refrigerated space of varying temperatures required for foods stored by families. Since heights needed are dependent on the heights of foods and containers to be stored, they were measured.

3. The frequency of use of refrigerated spaces of varying temperatures for foods stored by families. Since the kinds of refrigerated foods used most frequently should be stored most conveniently, how often refrigerated spaces are used by families was determined.

How the overall purpose was accomplished is delineated in the remaining chapters. The methods used in gathering and analyzing the data follows in the first section of this study. The methods chapter is followed by a discussion of the findings and the summary and conclusions are given in the last chapter.

CHAPTER II

METHOD

The amount, dimensions, and frequency of use of food stored in the refrigerators for thirty-nine families in Guilford County, North Carolina, were tabulated during February, 1960.

The thirty-nine families were selected on the basis of their having one or more children in order that the amounts and frequency of use of refrigerated foods could be studied by varying family sizes and ages of children. The families were further selected on the basis of their owning a refrigerator of at least ten cubic feet. Thus the size of the refrigerator should not be a limiting factor in the amount of food stored.

Each of the thirty-nine homemakers was interviewed for personal data. These data included the size of the family, ages of the family members, occupation of the father, description of the family meal patterns, and the amount and type of entertaining by the family. The form for recording the interview data and the measurements of refrigerated foods may be referred to in the Appendix, page 49.

The food in the refrigerator was inventoried on the day of the interview. As the food was removed from the refrigerator, foods requiring similar types of storage were grouped together. These food groups were fresh fruits, fresh vegetables, frozen fruits, frozen vegetables, fresh meat, frozen meat, liquids, milk, dairy products, accompaniments, left-overs, salads, ice cream, canned foods, and medicine. Each of the foods was measured and the three dimensions recorded. Thus the amount of food each homemaker had in the refrigerator on the day of the visit was recorded.

The maximum amount of food stored in the refrigerator by each family was to be established. Since the day the interview was made was not necessarily the day following the large weekly grocery shopping, a record of the weekly food purchases for the family was kept.

The first purpose was to determine the amount of refrigerated space of varying temperatures needed by each of the food groups. To achieve this, the record of food purchased for a week and the inventory record of the contents of the refrigerator were used as a basis for estimating the maximum amount a family stored for one week.

There are five varying temperatures in refrigerators for food storage: frozen, moist cold, very cold, less cold, and cold.

Food groups were classified according to desirable temperatures; for example, frozen fruits belong in the frozen storage space division. The distribution of amount of frozen fruit used by the thirty-nine families was expressed as percentiles and the mean amount of frozen fruit computed. This procedure was repeated for the remaining food groups in each space division.

It was of interest to determine the relationship between the amount of food stored and the frequency with which it was used. Families were categorized into a four celled table according to whether they stored large or small amounts of frozen fruits and whether they used these frequently or infrequently. The table was analyzed using a Chi Square test for contingency table. This procedure was repeated for the other food groups.

A further interest was to determine the relationship between the amount of food needed and the number of meals served by the family in a week. Analyses similar to those described above were made to test the significance of these relationships for the various food groups.

The second purpose was concerned with establishing the dimensions of refrigerated storage space required for the storage of foods. The depth, height, and length of each food or container was used to determine the dimensions required for the storage of foods in each storage space division.

The third purpose was concerned with recommendations for convenient placement of storage space divisions within the refrigerator. To arrive at these recommendations, records were needed of how often food was removed from the refrigerators. Family members of varying ages kept records of the removal of foods from the refrigerator. People were classified by age groups and the mean frequency of use by food groups was determined. Use of the refrigerator by children was further studied according to which foods were taken from the storage space divisions of the refrigerator.

The number of times the refrigerator was used by all members of each family was summarized. Mean frequencies of family use for each food group within each storage space division were then computed.

Some terms which will be used throughout this study are

1. Storage space divisions are divisions of the refrigerator space according to varying types of coldness, varying heights of space, and varying fragility and perishability of the foods to be stored.

2. Food groups consist of a group of similar foods such as fresh vegetables, frozen fruits, or leftovers.

3. Amount is used to designate cubic inches of space.

CHAPTER III

THE FAMILIES AND THEIR REFRIGERATORS

The Families

Thirty-nine families, all of whom had one or more children (or an average of 2.1 children) cooperated in supplying the data. The children varied in age from less than a year to seventeen years, with 65 per cent between the ages of two to nine (Table I).

TABLE I

AGES OF THE CHILDREN

Years	Number
1 and under	8
2 to 5	25
6 to 9	24
10 to 13	16
14 to 17	9

All but one of the homes had two adults and the families were divided almost equally in one, two, or three children per family (Table II).

TABLE II

NUMBER OF FAMILIES MADE UP OF VARIOUS NUMBERS OF ADULTS AND CHILDREN

	Number of People				
	One	Two	Three	Four	Five
Adults	--	38	1	--	--
Children	11	14	13	1	--
Family members	--	--	11	14	14

Sixty-six per cent of the fathers in the families were professional businessmen, while thirty-three per cent were skilled workers. Thirty-three percent of the homemakers worked outside the home full time and five per cent worked part time. About ninety-two per cent of the families owned their own homes.

The Refrigerators

Almost all (98 per cent) of the refrigerators were located in the kitchen, while only one was located out of the kitchen area.

For use in storing, removing and using foods at the refrigerator, some work surface is needed on the side of the refrigerator on which the handle is located. Fifteen (38 per cent) of the refrigerators did have usable work surface next to the correct side of the refrigerator.

In twenty-four of the homes (62 per cent) a work surface was not located correctly according to the refrigerator door opening. Some had the door on the wrong side, some were next to another appliance and some of the refrigerators were placed alone. Thirteen per cent of the doors swung toward the work surface. Thus it was necessary for the homemaker to walk around the door each time she wished to place food on the work surface. Thirteen per cent were placed immediately beside a washer, dishwasher or wall oven without a work surface for placing food at the refrigerator. Fourteen (35 per cent) of the refrigerators were located alone. In order that the homemaker will not have to make unnecessary steps for the storage and removal of foods at the refrigerator, it is essential that the refrigerator be conveniently located within the kitchen work area.

Age of Refrigerators. None of the refrigerators was more than twelve years old. Age of the refrigerators according to model year is given in Table III.

TABLE III

REFRIGERATORS ACCORDING TO MODEL YEAR

Model	Number
1948 - 1950	6
1951 - 1953	11
1954 - 1956	10
1957 - 1959	11
1960	1

Size of Refrigerators. A third of the refrigerators were ten cubic feet in size. Eighty-two per cent ranged from ten to twelve cubic feet inclusive. (Table IV).

TABLE IV

SIZE OF REFRIGERATORS

Cubic Feet	Number	Per Cent
Ten	13	33.3
Eleven	10	25.6
Twelve	9	23.1
Thirteen	3	7.7
Fourteen	3	7.7
Fifteen	1	2.6

Refrigerator Divisions. Seventy-two per cent of the refrigerators had a freezer compartment at the top of the refrigerator, while only eight per cent had a freezer compartment at the bottom. Twenty per cent of the refrigerators had a small vertical compartment with space for only a small amount of frozen foods in addition to a few ice trays.

Almost half of the refrigerators had four shelves for food storage; the rest had three. One homemaker took a shelf out in order that she could have greater height for the storage of tall containers. Nearly two-thirds (62 per cent) of the homemakers stated a desire for more tall storage space within the refrigerator.

Over half (54 per cent) of the shelves in the refrigerator would pull out or revolve in order to make food accessible and easy to reach. Only sixteen per cent of these homemakers stated that they made a practice of pulling out or revolving the shelves when using the refrigerator. The primary reason given by the homemakers for not adjusting the shelves was that they did not think about it.

All of the refrigerators contained some type of built-in storage. The kinds of special storage areas built into the refrigerator are given in Table V.

All of the refrigerators contained storage drawers with covers to retain moisture. The homemakers said they used them primarily for the storage of fresh fruits and vegetables. Ninety per cent of the homemakers stated that when fresh fruits and vegetables were purchased in a plastic bag that they stored them in these moist drawers in the plastic bags. Ten per cent of the homemakers preferred to remove the fruits and vegetables from the bags and place them directly into the covered drawers.

Half of the homemakers used the meat drawer for the storage of fresh meats. The remaining half had taken their fresh meat compartment out of their refrigerators because they were too small.

TABLE V

REFRIGERATORS HAVING VARIOUS KINDS OF STORAGE FACILITIES

Storage Divisions	Number	Per Cent
Freezer Location		
Top	28	71.68
Bottom	3	7.68
Vertical	8	20.48
Shelves		
Two	2	5.12
Three	19	48.64
Four	18	46.08
Covered Drawers	39	100.00
Shelves In Door		
Two	4	10.24
Three	13	33.28
Four	8	20.48
Door Compartments		
Butter	15	38.40
Cheese	7	17.92
Eggs	20	51.20
Meat Drawer	39	100.00

Contrary to common recommendation that fresh meat be loosely wrapped for storage, almost half of the meat was placed in the refrigerator in the grocery store wrapping. The homemakers rewrapped the rest either in waxed paper (25 per cent) or in aluminum foil or plastic bags (25 per cent).

Twenty (51.2 per cent) of the refrigerators contained a storage compartment for eggs in the door. All but one of the homemakers said that they liked this location because the eggs were so easy to reach when preparing meals in a hurry. However, one of the homemakers felt

that having to remove the eggs from a carton to store in the individual holders in the door required too much time.

The butter containers located in the door numbered fifteen (38 per cent). Two of the homemakers suggested that the butter and cheese compartment needed to be larger in order to accommodate these foods in the size in which they were purchased at the grocery store.

The number of trays of ice the homemakers used in the winter - between two and three - were less than those estimated for use in the summer - between three and four (Table VI).

TABLE VI

SEASONAL USAGE OF ICE TRAYS

Number of Trays	Summer	Winter
One	--	5
Two	8	18
Three	11	14
Four	17	1
Five	1	1
Six	2	--

CHAPTER IV

THE AMOUNT OF REFRIGERATED STORAGE SPACE USED

Storage Space Divisions

In planning recommended storage space divisions for refrigerators, consideration was first given to the types of cold and degrees of moisture that are available. Most refrigerators provide five types of cold or moisture. They are freezing, very cold, cold, less cold, and moist cold. A second consideration was the dimensions of the food or food containers that need to be stored in each type of cold. For example, milk and liquids require tall space in the cold division. A third consideration was the relative perishability. Leftovers, for example, spoil quickly and are more apt to be used if easily seen.

All of the foods that required refrigeration for the thirty-nine families for the period of a week were classified according to where they should be stored.

The Amounts

Milk required the largest amount of refrigerated space needed by any foods used by the thirty-nine families studied. (Table VII) Liquids other than milk also were very high; in fact they were second in total amount of space required for storage. Both of these foods combined were, on the average, about twice as large as any other type or division. The total for this group was 1214 cubic inches.

TABLE VII

CUBIC INCHES OF SPACE FOR FOOD GROUPS USED BY THE FAMILIES ACCORDING TO REFRIGERATOR DIVISIONS

Storage Space Divisions	Percentiles					
	5th	25th	50th	75th	95th	Mean
Frozen						
Fruits	0	0	46	103	205	62
Vegetables	0	53	128	202	724	162
Meat	0	153	333	604	933	412
Ice	88	176	176	176	240	128
Ice Cream	0	0	0	123	134	29
Total Groups	88	382	683	1208	2236	793
Moist Cold						
Fresh Vegetables	228	370	468	740	931	380
Fresh Fruits	39	227	388	1120	1580	331
Total	267	597	856	1860	2511	711
Very Cold						
Fresh Meat	148	217	306	464	876	216
Less Cold						
Dairy Products	122	133	192	281	649	316
Cold						
Tall Storage						
Liquids	0	166	340	534	1097	394
Milk	288	576	720	1152	1728	820
Total Group	288	742	1060	1686	2825	1214
Fragile						
Eggs	322	324	468	475	972	523
Long Term						
Accompaniments	254	508	692	884	1415	710
Short Term						
Leftovers	45	304	414	614	1258	497
Salads	0	0	0	0	0	12
Total Groups	45	304	414	614	1258	509
Miscellaneous						
Medicine	0	0	0	3	40	9
Special	0	0	0	0	123	12
Canned Goods	0	0	0	56	288	58
Total Group	0	0	0	59	451	79
Total Food Groups	1534	3207	7878	15408	13193	5071

Space for foods requiring frozen temperatures and space for foods requiring moist cold temperatures were about the same for the families studied. Therefore these two types of storage space divisions are next in importance when considered from the standpoint of amount of space that is needed.

After the above food groups accompaniments, which were salad dressings, pickles, and catsup, were next in importance. Leftovers required the next largest amount of space. These two require about the same temperature in the refrigerator, but they are stored for different lengths of time. Leftovers, particularly since they are prone to spoilage, are considered as short-term storage.

Eggs, fresh meat, and dairy products ranked consecutively lower in amounts of space required for storage.

Those families who store extremely large amounts of some foods required more space for such foods than would be needed by the majority of the families. In order to eliminate such extremes, the amount of space used by the top five per cent was eliminated. The amounts of refrigerated space used for food groups by the ninety-fifth percentile was arbitrarily chosen as it not only satisfies the storage needs of the large majority of the families but also allows flexibility in food purchases. The fiftieth percentile is not recommended because half of the families would not be satisfied with that amount of refrigerated space.

It must be remembered that this study was of winter refrigerated storage needs rather than of summer storage requirements. The summer months would undoubtedly show larger amounts of space needed for liquids, and fresh fruits and vegetables.

The amounts of the food groups as listed here do not include space at the top and side of the containers. Space is needed for easy storage and removal of foods in the refrigerator and for circulation of air for the cooling of foods.

Meals Prepared In the Home

The thirty-nine homemakers prepared a total of 381 meals each day, or an average of nine meals per day per family (Table VIII).

TABLE VIII

NUMBERS OF FAMILIES IN WHICH DIFFERENT NUMBERS OF MEALS WERE SERVED

Persons Per Meal	Meals Prepared			Total Meals
	Breakfast	Lunch	Dinner	
Zero	4	3	0	0
One	0	7	0	7
Two	5	13	0	36
Three	7	9	13	87
Four	13	5	13	124
Five	9	2	12	115
Six	1	0	1	12
Total	39	39	39	381

Relationship Between Number of Meals Served and Amount of Food. The significance of the relationships between the number of meals served and the amounts of food groups stored in the refrigerators was determined by Chi Square using the contingency table of analysis.

The amount of fresh fruits stored was related significantly to the number of meals the family served in a week (Table IX).

The amounts of milk and liquids were related significantly to the number of meals served by the families in a week.

The total food groups, with the exception of accompaniments, were related significantly to the number of meals families served in a week. Since families did not use all of the accompaniments which were stored in the refrigerator at a meal, it is not surprising to find that the amount stored was not related significantly to the number of meals served by the family.

TABLE IX

SIGNIFICANCE OF THE RELATIONSHIP BETWEEN NUMBER OF MEALS SERVED BY THE FAMILY FOR ONE WEEK AND THE AMOUNTS OF VARIOUS KINDS OF FOOD STORED IN THE REFRIGERATOR

Refrigerated Foods	Significant Level Relationship of Amounts to Number of Meals
Fresh fruits	1%
Frozen fruits	N.S.*
Fresh and frozen fruits	1%
Fresh, frozen and canned fruits	1%
Fresh fruits and fresh vegetables	1%
Fresh vegetables	N.S.
Frozen vegetables	N.S.
Fresh and frozen vegetables	N.S.
Frozen fruits, vegetables, meat and ice cream	N.S.
Fresh meat	N.S.
Frozen meat	N.S.
Fresh and frozen meat	N.S.
Dairy products	N.S.
Eggs	N.S.
Fresh and frozen meat and eggs	N.S.
Milk	1%
Liquids	1%
Accompaniments	N.S.
Leftovers	5%
Total Food Groups**	1%

*Not significant.

**Does not include accompaniments.

The number of meals served by the families in a week was not related significantly to the amount of fresh and frozen vegetables. Possibly some families used canned vegetables or fresh vegetables which did not require refrigeration.

The amount of fresh and frozen meat was not related significantly to the number of meals served by the families. It may be that as the number of meals served by the family increased, the amount of meat for each meal decreased.

CHAPTER V

THE FREQUENCY OF USE OF REFRIGERATED FOODS

The frequency of use of refrigerated foods needs to be a basis for planning convenient placement of storage divisions within the refrigerator. The amount of time and energy required to prepare meals for the family may be lessened if the refrigerated foods are easy to see and to reach.

One of the most important findings of this study was the frequency of use of refrigerated foods by the families (Table X).

Since the tall storage space was used almost twice as frequently as any other storage division in the refrigerator it needs to be located in the most easily seen and easily reached part of the refrigerator. The family should see and reach this storage space without excessive bending, searching and reaching behind other storage.

Moist cold storage, long term storage, and less cold storage were used almost the same number of times by the families. It is difficult to say that any one of these refrigerated storage divisions should have priority over the other two in convenient placement within the refrigerator. All of these storage areas need to be easily seen and easy to reach.

Very cold storage, frozen storage, fragile storage and short term storage ranked lower in the frequency with which the divisions were used.

TABLE X

FREQUENCY OF USE OF REFRIGERATED STORAGE SPACE DIVISIONS PER DAY PER FAMILY

Storage Divisions	Mean	95th Percentile	Rank
Frozen			
Fruits	.28	1	
Vegetables	.44	1	
Meat	.07	1	
Ice	.92	4	
Ice Cream	.51	2	
All Frozen	2.18	5	5
Moist Cold			
Fresh vegetables	2.23	6	
Fresh fruits	1.36	6	
All Moist Cold	3.59	9	3
Very Cold			
Fresh Meat	2.74	5	5
Less Cold			
Dairy products	3.51	7	3
Cold			
Tall storage			
Liquids	4.66	12	
Milk	5.56	10	
All Tall Storage	10.23	17	1
Fragile			
Eggs	1.44	3	8
Long term			
Accompaniments	3.66	8	3
Short term			
Leftovers	1.10	4	
Salads	.51	3	
All Short Term	1.62	5	7

It must be remembered, however, that the record of the number of times the families used the storage space divisions was the day following the large weekly grocery shopping. The families stated that they froze fresh meat two days after marketing. It is possible that on the other days of the week more frozen meat would be used rather than fresh meat.

It must also be remembered that this study was of winter storage rather than summer. Undoubtedly more ice and frozen juice would be used in the summer.

Fragile storage is needed for one food - eggs. Although the frequency with which eggs were used ranked eighth, it does not mean that they should be located in an inconvenient place within the refrigerator. Eggs should also be accessible for use by the family.

Since leftovers and salads are highly perishable, short-term storage needs to be placed so that the family can see them easily and use them before they spoil.

All storage divisions need to be placed so that they may be easily seen and reached by the family. All foods are highly perishable and require spaces which are convenient and accessible for use.

Frequency of Use by Food Groups and by Types of Refrigerated Storage

The frequency with which any type of refrigerated storage space was used varied from one to twenty-one times a day (Table XI).

Milk and liquids were the most frequently used food groups. Thus tall storage space division was the most frequently used refrigerated space.

TABLE XI

FREQUENCY OF USE BY FOOD GROUPS AND BY TYPES OF REFRIGERATED STORAGE

Storage Divisions	Number of Times Used Per Day															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	(Number of Families)															
Frozen																
Fruits	32	5	1	1												
Vegetables	23	15	1													
Meat	36	3														
Ice	22	9	2	1	4				1							
Ice cream	27	8	2	1	1											
All frozen	7	12	9	3	4	1	1	1		1						
Moist Cold																
Fresh vegetables	8	9	7	7	3	2	1	1	1							
Fresh fruits	6	11	6	1	2		2	1								
All moist cold	3	6	9	8	3	2	2	3		1		1			1	
Very Cold																
Fresh meat	2	5	10	14	4	2		2								
Less Cold																
Dairy products	3	5	12	10	1	3	1	2	1			1				
Cold																
Tall Storage																
Liquids	3	9	2	4	2	2	6	4	1	2		1	2		1	
Milk	1	3	5	3	1	5	4	7	2	4	3	1				
All Tall Storage	1		2		1	1		3	5	7	2	5	1	5	1	5
Fragile																
Eggs	6	17	9	7												
Long-Term																
Accompaniments	4	4	6	6	7	3	3	2	2	2						
Short Term																
Leftovers	21	6	2	7	3											
Salads	28	6	2	2	1											
All Short-Term	18	5	4	3	6	3										

The moist cold storage division was used by thirty-six of the thirty-nine families with the second greatest number of frequencies.

Amounts of Food Groups Related to Frequency of Use

The amounts of fresh fruits, fresh and frozen vegetables, and accompaniments stored in the refrigerator were related significantly to the frequency with which families used these foods (Table XII).

TABLE XII

SIGNIFICANCE OF THE RELATIONSHIP BETWEEN THE AMOUNTS OF VARIOUS KINDS OF FOOD STORED IN THE REFRIGERATOR AND THEIR FREQUENCY OF USE

Refrigerated Foods	Significance Level Relationship of Amount to Frequency of Use
Fresh fruits	5%
Frozen fruits	N.S.*
Fresh and frozen fruits	N.S.
Fresh, frozen and canned fruits	N.S.
Fresh fruits and fresh vegetables	N.S.
Fresh vegetables	N.S.
Frozen vegetables	N.S.
Fresh and frozen vegetables	5%
Frozen fruits, vegetables, meat and ice cream	N.S.
Fresh meat	N.S.
Frozen meat	N.S.
Fresh and frozen meat	N.S.
Dairy products	N.S.
Eggs	N.S.
Fresh and frozen meat and eggs	N.S.
Milk	N.S.
Liquids	N.S.
Accompaniments	1%
Leftovers	N.S.
Total Food Groups	N.S.

*Not significant.

The amounts of fresh and frozen meat, dairy products, frozen fruits and vegetables, and fresh vegetables stored in the refrigerator were not related significantly to the frequency with which the foods were used. Trips were made to get these foods from the refrigerator, regardless of the amount stored.

The Family Size Related to the Frequency with which Foods were Used

Families with five members stored the largest amount of food and therefore required the largest amount of storage space, 500 cubic inches more storage space than did families of three members. Families with five members required about 1500 cubic inches more than did families with four members. This would indicate that there is no proportionate number of cubic inches required by an addition of one member in a family in the thirty-nine families studied (Table XIII).

TABLE XIII

FAMILY SIZE RELATED TO AMOUNTS OF FOOD STORED IN THE REFRIGERATOR AND HOW FREQUENTLY THE FAMILIES USED REFRIGERATED FOODS

	Number in Family		
	Three	Four	Five
Average cubic inches of food per family*	4328.89	4866.96	6454.81
Average frequency of use per family per week**	27.1	29.9	29.1

*Significant at five per cent level.
**Not significant.

The average amounts of food stored were related significantly at the five per cent level to the size of the family. It may also be

remembered that the number of meals served in a week was related significantly (1 per cent level) to the amount of food used in a week.

The families with four members used food from the refrigerator a slightly greater number of times than did families consisting of three or five members. However, the number of members in a family was not related significantly to the frequency with which the refrigerated foods were used. Possibly the amount of food which was taken from the refrigerator was larger as the family size increased rather than increasing the number of times the homemaker required food from the refrigerator.

Frequency of Use of Food Groups Per Week By All Children, Husbands and Wives in Total Families

The wives used all of the refrigerated storage divisions a greater number of times than did the children and husbands.

TABLE XIV

FREQUENCY OF USE OF FOOD GROUPS PER WEEK BY ALL CHILDREN, HUSBANDS AND WIVES IN TOTAL FAMILIES

Storage Divisions	Children	Husbands	Wives	Families
Frozen	2.55	2.94	8.42	10.30
Moist Cold	3.50	3.89	17.81	25.21
Very Cold	1.16	4.65	13.28	19.11
Less Cold	2.75	3.47	14.12	20.35
Cold				
Tall Storage	23.65	19.00	30.41	72.99
Fragile	.30	1.97	7.71	10.01
Long Term	4.21	5.58	16.08	25.86
Short Term	1.47	1.92	7.50	10.89
Total	59.59	43.42	115.33	194.72

All of the families used the tall storage division a greater number of times than any type of refrigerated storage space. The families used tall space almost three times more often than any type of storage space. Of the total number of times the families used tall storage, children used this storage thirty-three per cent of the time.

Moist cold storage and long-term storage, frozen and fragile storage ranked consecutively lower in the number of times all the family used the storage.

Frequency of Use of Food Groups by Children, Husbands, and Wives in Various Size Families for One Week

Wives in families of all sizes took food from the refrigerator a greater number of times than any other member of the family (Table XV).

Tall storage space was used the most frequently by the children, by the husbands and by the wives in the families studied regardless of the size of the family. Thus tall storage space was used more frequently than any other types of storage space.

In families of three members, long term storage ranked second, with moist cold storage and very cold storage ranking consectuively lower in the frequency of use.

In families consisting of four members, moist cold storage for fruits and vegetables ranked second and long term storage, less cold storage and very cold storage ranked consecutively lower in the frequency with which the foods were used.

For five member families the rank for the frequency with which the foods were used was tall storage, moist cold, long-term, less cold and very cold.

TABLE XV

FREQUENCY OF USE OF FOOD GROUPS PER WEEK BY CHILDREN, HUSBAND AND WIFE IN FAMILIES OF THREE, FOUR AND FIVE MEMBERS

Food Groups	Number in Family											
	Three				Four				Five			
	C[1]	H[2]	W[3]	F[4]	C[1]	H[2]	W[3]	F[4]	C[1]	H[2]	W[3]	F[4]
Frozen	.6	3.8	11.5	15.9	3.0	3.5	8.0	14.5	4.0	1.5	6.0	11.5
Moist Cold	.0	3.2	18.5	21.6	6.5	5.5	14.5	26.5	4.0	3.0	20.5	27.5
Very Cold	.0	4.5	13.4	17.8	2.5	6.0	12.0	20.5	1.0	3.5	14.5	19.0
Less Cold	1.3	1.9	13.4	16.5	2.5	4.5	18.5	25.5	4.5	4.0	10.5	19.0
Cold												
Tall	11.5	22.7	33.7	67.5	23.0	24.0	32.5	79.5	36.5	10.5	15.0	72.0
Fragile	.0	1.9	7.6	9.5	.5	2.5	6.0	9.0	.5	1.5	9.5	11.5
Long Term	.6	5.7	19.7	26.1	5.5	7.0	13.5	26.0	6.5	4.0	15.0	25.0
Short Term	1.9	1.3	7.0	10.2	2.0	4.0	10.0	16.0	.5	.5	5.5	6.5
Total	15.9	45.0	124.8	185.1	45.5	57.0	115.0	217.5	57.5	23.5	106.5	192.5

[1]Children

[2]Husband

[3]Wife

[4]Family total

Families of four members used almost all of the foods a greater number of times in a week than did those families with three or five members.

The number of times each child in the families with five members got food from the refrigerator was higher than for the children in the families consisting of one or two children. However, in the five member families, the husband and wife got food from the refrigerator fewer times than did husbands and wives in families of three or five members. Apparently the children in the five member families helped in food preparation.

It must be remembered that the frequency with which these families used refrigerated foods did not include the number of times they opened the door of the refrigerator to store food or to return partially used food.

Average Frequency of Use of Refrigerated Food by Different Age Individuals

Women used the refrigerator almost four times as frequently as did the children or men (Table XVI).

TABLE XVI

AVERAGE FREQUENCY OF USE OF REFRIGERATED FOODS PER WEEK PER INDIVIDUAL BY AGE

Age of Children	Average Frequency
3 to 5 years	19.6
6 to 8 years	19.2
9 to 11 years	23.9
12 to 14 years	25.1
15 to 17 years	24.1
Men	34.9
Women	113.6

The average frequency with which children used refrigerated foods varied slightly. Children between the ages of twelve and fourteen got food from the refrigerator a slightly greater number of times than did children of any other age. However, the age of the children was not related significantly to the average frequency with which refrigerated foods were used.

Men took food from the refrigerator more frequently than did children of any age. However, all children took food from the refrigerator more frequently than did men.

Frequency of Use of Food Groups by Different Age Children

All of the children used milk and liquids more often than any space division. In fact children used tall storage space four times as frequently as any type of storage space. All of the children used long term storage the second greatest number of times. Ranking third in use by children, is moist cold storage. Storage for dairy products ranked fourth in frequency of use by children (Table XVII).

TABLE XVII

AVERAGE FREQUENCY OF USE OF REFRIGERATOR SPACE DIVISIONS PER WEEK PER CHILD ACCORDING TO AGE

Space Divisions	Age in Years				
	3-5	6-8	9-11	12-14	15-17
Frozen Foods	.33	1.00	.58	1.55	.00
Moist Cold	2.00	3.30	3.50	1.55	1.66
Very Cold	.66	1.00	1.16	2.33	1.66
Less Cold	1.60	1.33	1.75	2.33	1.66
Cold					
Tall	12.30	8.60	12.25	14.22	11.66
Fragile	.33	1.00	.58	.00	2.33
Long Term	2.00	1.60	4.08	3.11	3.50
Short Term	.33	1.33	.00	.00	1.66
Total	19.55	19.16	23.90	25.09	24.13

The height of the children at varying ages needs to be considered in the placement of storage areas within the refrigerator. Since children used milk the most frequently, some tall space may be planned within their reach. This space needs to be convenient in order that the children can see the food and avoid spilling food in the refrigerator. Not all tall storage should be placed low within the reach of children. Mothers, who use this storage the most frequently should not have to bend or strain to see this space. Children should be given some consideration as they have some responsibility for waiting on themselves when the mother is busy and helping mother when she is in the kitchen.

To meet the requirement that children be able to reach those foods which they use the most frequently, possibly adjustable shelves in the refrigerator should be considered. Shelves could be added, removed or raised as the children grow in height.

CHAPTER VI

DIMENSIONS OF REFRIGERATOR STORAGE SPACE DIVISIONS

Recommended usable dimensions for the refrigerated storage divisions were determined from the dimensions of the largest foods and containers stored in them. Storage space divisions that are too small to accommodate the sizes of foods or containers that homemakers wish to place in them are obviously too small for convenient use. Storage space divisions that are higher or deeper than required for the sizes of foods and containers that are to be stored in them, would have wasted space. Such space might better be added to the other storage space divisions within the refrigerator.

Minimum heights for each of the refrigerated space divisions were based on the tallest foods or containers stored in each of the divisions. Adjustable shelves can be used as a solution for varying needs in height.

Minimum depths for each of the storage space divisions were determined by the maximum depths of foods and containers that the homemakers would ordinarily want to store in them. In some cases foods or containers would be stored more than one deep, in which cases minimum depths were determined for the multiples.

Minimum lengths for each of the refrigerated space divisions were determined according to two basic considerations. First, the minimum length required for the largest size of food or container ordinarily stored in such a division was determined. Second, using the established minimum height and depth, the length needed to provide the total

recommended amount of space was determined. Data establishing the needed length for each of the storage space divisions is given in Table XVIII.

TABLE XVIII

AMOUNTS, PERCENTAGES AND DIMENSIONS FOR THE REFRIGERATED SPACE DIVISIONS BASIC TO THE DETERMINATION OF THEIR LINEAR REQUIREMENTS

Refrigerated Storage Space Divisions	Cubic Inches of Storage Space Needed	Square Inches Provided by Minimum Heights and Depths	Per Cent of Total Space Needed	Linear Inches Needed to Satisfy Cubic Inch Requirement
Frozen	2236	120	17.5	18.6
Moist Cold	2511	72	19.7	34.9
Very Cold	876	72	6.8	12.2
Less Cold	649	84	5.1	7.7
Cold				
Tall Storage	2825	120	22.2	23.6
Fragile	972	84	7.6	11.6
Long-Term	1415	84	11.1	16.8
Short-Term	1258	72	9.8	17.4
Total	12742		100.0	

Minimum dimensions for the storage space divisions in refrigerators are given in Table XIX and are discussed for each of the eight storage space divisions below.

Frozen Space Division

The tallest container usually stored in this division is a gallon container of ice cream which is ten inches in height. The height required to freeze a large turkey would be greater, but since this food is not usually frozen in a refrigerator, the required height would be an excessive height to recommend as a minimum to accommodate the foods and containers used by the majority of the families.

TABLE XIX

RECOMMENDED DIMENSIONS FOR CONVENIENT REFRIGERATED STORAGE SPACE DIVISIONS[1]

Refrigerator Storage Space Divisions	Minimum Dimensions[2]			Minimum Length Required by Recommended Amount[3]
	Height	Depth	Length	
Frozen	10.0	12.0	10.0	18.6
Moist Cold	6.0	12.0	6.0	34.9
Very Cold	6.0	12.0	6.0	12.2
Less Cold	7.0	12.0	4.0	7.7
Cold				
Tall Storage	10.0	12.0	8.0	23.6
Fragile	7.0	12.0	8.3	11.6
Long-Term	7.0	12.0	4.0	16.8
Short-Term	6.0	12.0	6.0	17.4

[1]Amount of space required for handling foods and air circulation not established.

[2]Minimum dimensions are determined by sizes of food and containers stored in the particular space divisions.

[3]Minimum length required to provide the total amount of space needed to store the amount of foods which the majority of the 39 families used.

The depth of the frozen space division needs to accommodate at least two packages of frozen food. Two of the larger size packages require ten inches. The gallon of ice cream could be stored lengthwise in the space, but if stored with the longer depth from front to back, this space would need to be at least twelve inches in depth. Ice cube trays are generally about eleven inches in depth. However, the trays may be made in any size dependent upon the design of the storage space.

In order to accommodate ice trays and a frozen food package, the length of the frozen food division needs to be at least ten inches. This length, with ice trays and all other foods removed, would also store a gallon of ice cream and would be the minimum for very small

refrigerators. This space would not accommodate the foods and containers that the families used from this division. In order to provide the total amount of space needed, the square inches provided by the recommended minimum height and depth were divided into the cubic inches required by foods used by the majority of the families.

In order to meet the cubic inch requirement for frozen foods, the length of the frozen food division needs to be at least 18.6 inches (Table XVIII).

Therefore, a height of ten inches, a depth of twelve inches and a length of 18.6 inches are minimum dimensions to satisfy the needs of the majority of families studied for containers stored in the frozen food division of a refrigerator.

Moist Cold Space Division

The height for moist cold storage should be tall enough to store big heads of lettuce or cabbage which are six inches high. Based on the length of celery, the longest food usually stored in this space division, the depth needs to be eleven inches. Since the depth of all the storage space divisions needs to be considered and an overall depth recommended that will satisfy all foods and containers in the box, a depth of twelve inches is here again established as the minimum.

The length for the moist cold division, as determined from the minimum height and depth and from the total cubic inches required for the foods used by the majority of the families, is 34.9 inches (Table XVIII).

Therefore a height of six inches, a depth of twelve inches, and a length of 34.9 inches are minimum dimensions to satisfy the needs of the thirty-nine families for containers stored in the moist cold division of a refrigerator.

Very Cold Space Division

The minimum height recommended for the very cold division is six inches. This height is based on the tallest height required to store the majority of roasts. In cases where unusually large roasts or fowls are purchased, it is assumed that families intend to use them within a short period of time and that they could be stored in another location in the cold division for such a short period. In any case a height of more than six inches would be excessive to meet the needs of the thirty-nine families most of the time and hence would not be an economical use of space nor of refrigerator operation.

A depth that will accommodate large steaks and pound packages of bacon is ten inches. In order to conform to the depth required for other food divisions, a minimum of twelve inches is recommended as it would amply accommodate the foods stored here. The length recommended to meet the minimum requirements in order to store the quantity of foods that most of the families needed for this space division, determined from the total cubic inches of space needed and the square inches recommended for height and depth, is 12.2 inches. A minimum for very small refrigerators in order to store even small amounts is six inches.

Less Cold Space Division

The minimum height, as established by the height requirements of a pound of butter, is four inches. Cheese requirements are rarely higher than this. The minimum depth required by this space division is established by the depth that would accommodate the majority of cheeses. This measurement was determined to be a minimum of eight inches. However, if the space divisions for cheese and butter are separated, the depth required for the storage of butter is 5.25 inches. Here again a depth of twelve inches would amply meet the storage requirements for the foods of this division and conform to those required for other divisions.

The length required to store the majority of the sizes of cheese is five inches. Butter and margarines would require less, four inches. The length required to store the quantity of dairy products stored by the majority of the families, calculated from the total space requirement and the minimum height and depth, is 7.7 inches.

Therefore, a height of four inches, a depth of twelve inches and a length of 7.7 inches are minimum dimensions to satisfy the needs of the thirty-nine families for foods and containers stored in the less cold division of a refrigerator.

Tall Storage Space Division

The height for the tall space division should accommodate a large bottle of soda, which is twelve inches high. Such a bottle might be stored in the door in which case the maximum height required would be dependent on the height of a bottle of milk, ten inches.

The minimum depth needed to store a single bottle of soda is three inches. The minimum depth needed to store a bottle of milk is four inches. The twelve inch depth recommended for the other space divisions would therefore accommodate three bottles of milk.

A minimum length established by the requirements of two bottles of milk is eight inches. No less than this amount of space should be considered when planning the space division for very small refrigerators. The minimum length required to store the amount of milk and liquids used by the majority of the families is 23.6 inches.

Therefore, if a twelve inch height for tall bottles is included in the door storage, a height of 10.0 inches, a depth of 12 inches and a length of 23.6 inches are minimum dimensions to satisfy the needs of most of the thirty-nine families for foods and containers stored in the tall storage division of a refrigerator.

Fragile Storage Space Division

The storage requirements of a carton of eggs determines the minimum dimensions for this space. Some may prefer other types of containers such as baskets, but they too could be designed to conform to the measurement requirements for eggs in cartons.

Stacked, two cartons of eggs would require 7.0 inches of storage height, 12 inches of depth and 3.3 inches of length. These are all minimum requirements. The minimum length that satisfied the storage requirements for the quantity of eggs stored by the families is 11.6 inches.

Long-Term Space Division

Based on the height of salad dressing, pickles and catsup, this space division requires a height of 6.5 inches. If such foods are to be stored on the door of the refrigerator, a minimum depth of four inches is required. However, if these foods are to be placed inside the refrigerator and stored two deep, a minimum depth of eight inches is required. A minimum of twelve inches amply accommodates the depths for such foods. Mayonnaise, when stored two deep, requires a depth of ten inches.

The minimum length to store a single jar of mayonnaise or pickles is four inches. The minimum length to meet the storage requirements for accompaniments for the majority of the thirty-nine families is 16.8 inches.

Short-Term Space Division

For the storage of most casseroles, or plastic containers for leftovers, a height of six inches is required. Some homemakers like to store foods in containers in which they are cooked and often complained that the spaces were too shallow for such storage.

The depth required for the storage of most platters is ten inches. This depth will also accommodate pie and cake plates and baking containers. Six inches is a minimum length needed for these containers. The length required as a minimum to meet the needs of the majority of the families for the quantity of leftovers and salads stored is 17.4 inches. Therefore a height of six inches, a depth of ten inches and a length of 17.4 inches are recommended.

Application of the Minimum Dimensions for the Storage Space Divisions

The minimum dimensions summarized in Table XIX can be applied to varying sizes of refrigerator interiors. Lengths that would be possible for each of the storage space divisions were calculated using the minimum height and depth as determined and assigning a percentage of the total space according to the percentages that the families used for each of the eight space divisions. The results of such calculations are given in Table XX. Note that the minimum length that would store the amounts of food the families stored was not met by the refrigerators that were four cubic feet in size. Likewise the six cubic foot refrigerator could not meet the minimum length of space requirement for any of the space divisions. The eight cubic foot refrigerator almost meets the requirements. The ten cubic foot refrigerator meets all of the minimum length requirements established.

TABLE XX

LENGTH IN INCHES OF REFRIGERATED STORAGE SPACE DIVISIONS POSSIBLE IN REFRIGERATORS OF VARYING SIZES WHEN MINIMUM HEIGHT, DEPTH AND PERCENTAGE OF TOTAL SPACE ARE CONTROLLED BASED ON FOOD PATTERNS OF THE THIRTY-NINE FAMILIES

Refrigerated Storage Space Divisions	Refrigerator Sizes*				
	4 Cubic Feet	6 Cubic Feet	8 Cubic Feet	10 Cubic Feet	12 Cubic Feet
Frozen	8.79	13.18	17.57	21.97	26.36
Moist Cold	16.44	24.66	32.85	41.10	49.33
Very Cold	5.74	8.61	11.48	14.34	17.21
Less Cold	3.64	5.47	7.28	9.11	10.93
Cold					
Tall	11.09	16.65	22.21	27.75	33.29
Fragile	5.45	8.18	10.92	13.65	16.37
Long-Term	7.94	11.92	15.89	19.87	23.84
Short-Term	8.24	12.36	16.49	20.60	24.73

*Ten per cent of total space was deducted to allow space for shelves and drawers.

These data indicate that at least nine cubic feet of refrigerated space are required in order to meet the needs of storage for the majority of foods used by families when the heights and depths of all of the spaces are kept at a minimum.

CHAPTER VII

SUMMARY AND CONCLUSIONS

The amount of refrigerated storage space required to store foods during a week's period was established by studying the refrigerated storage requirements of thirty-nine families in Guilford County, North Carolina, during February, 1960. Sixty-six per cent of the fathers in the families were professional businessmen, while thirty-three per cent were skilled workers. Thirty-three per cent of the homemakers worked outside the home full time and five per cent worked part time. These families had an average of two children. All but one of the families were urban residents. About ninety-two per cent of the families owned their own home and all had at least a 10 cubic foot refrigerator.

The purpose of this study was to establish a basis for planning convenient storage arrangements within the refrigerator. The overall purpose was considered to be threefold. To determine:

1. The amounts of refrigerated space of varying temperatures required for foods stored by the families.
2. The dimensions of refrigerated space of varying temperature required for foods stored by families.
3. The frequencies of use of refrigerated space of varying temperatures for foods stored by families.

The amount and types of food each family stored in the refrigerator for a week were determined from an inventory of the refrigerator and a record of all food purchases for the family for one week. All foods

and containers stored in the refrigerator were measured in order to determine the dimensions required for each storage space division. Members of each of the thirty-nine families kept a record of the frequency with which they used refrigerated storage space for one day following the large weekly grocery shopping.

The types of cold available in refrigerators and the sizes and types of foods and containers stored in them establish that there are eight major divisions of space to be considered in designing refrigerators for convenience of use. These space divisions and the types of food to be stored in each are:

A frozen space division for frozen fruits, vegetables, meat and ice cream and ice.

A moist cold space division for fresh fruit and vegetables.

A very cold division for fresh meats.

A less cold division for dairy products such as cheese, butter, and margarine.

A cold division for the remaining foods and containers which were subdivided into four types:

The tall storage division for milk and liquids.
The fragile storage division for eggs.
The long-term storage division for pickles and salad dressings.
The short-term storage division for leftovers and salads.

The amount of space required by the 95th percentile was arbitratily selected as a basis for recommending the amount of storage space needed by the thirty-nine families. This amount of space was used as a basis for recommendations as even with the extremes eliminated the refrigerated

storage needs for the majority of the thirty-nine families were satisfied. Milk required the largest amount of space needed by any foods used by the thirty-nine families studied. Liquids other than milk required the second largest amount of storage space. The frozen space division and moist cold space division required the next largest amount of space for the foods used by the families studied. The total amount of food stored by the families was related significantly to the number of meals served by the families.

The minimum dimensions for each of the eight major divisions of refrigerator space were established from the dimensions of foods and containers stored in them by the thirty-nine families. Minimum dimensions in inches for these eight divisions are:

	Height	Depth	Length
Frozen division	10.0	12.0	10.0
Moist Cold division	6.0	12.0	6.0
Very cold division	6.0	12.0	6.0
Less cold division	7.0	12.0	4.0
Cold			
Tall storage division	10.0	12.0	8.0
Fragile storage division	7.0	12.0	3.3
Long-Term division	7.0	12.0	4.0
Short-Term division	6.0	12.0	6.0

The minimum height and depth dimensions are recommended for the eight storage space divisions of all sizes of refrigerators. Additional height or depth would be wasteful of refrigerated space. A minimum length is recommended for small refrigerators, for example a four cubic foot refrigerator. This minimum length would allow a single container or regular size of the food to be stored but is not considered desirable.

The minimum lengths for each of the eight major food divisions that adequately store the refrigerated foods used by the thirty-nine families were:

Frozen division	18.6 inches
Moist cold division	34.9 inches
Very cold division	12.2 inches
Less cold division	7.7 inches
Cold, Tall division	23.6 inches
Cold, Fragile division	11.6 inches
Cold, Long-term division	16.8 inches
Cold, Short-term division	17.4 inches

Additional lengths of these spaces might be required for entertaining for holidays and during the summer months. These, therefore, are not recommended as most desirable but rather as the minimum to satisfy ordinary family needs during the winter months.

The minimum dimensions required for each storage space division were applied to varying sizes of refrigerator interiors. These data indicate that at least nine cubic feet of refrigerated space was required in order to meet the needs of storage for the majority of foods used by the thirty-nine families when the heights and depths were kept at an established minimum.

Frequency of use of each of the eight major space divisions determined the relative importance of the convenience of their location in the refrigerator. It was of first importance that the tall storage space for milk and liquids be easy to see and to reach; second in importance was the location of moist cold, space for fresh fruits and vegetables, less cold space for dairy products, and long-term space for accompaniments. The frozen food division and the very cold division for fresh meat ranked next. The storage space division for leftovers and for eggs did not rank as high as the

others in the relative importance of the convenience of their locations. However, both have special reasons why they too should be easy to see and to reach. The short term leftovers need to be convenient if they are to be used within their names "short-term," and the eggs, being a single food, might have ranked higher had other equally fragile foods been available to group with them.

This study of the use of refrigerated storage space of thirty-nine families establishes a basis for designing convenient refrigerated storage space to meet the needs of these families. This basis might be expanded to include how families use refrigerators on different occasions, at different seasons of the year, and during different periods of the family life cycle. Further studies might consider differences in refrigerator needs according to the size, income, and ethnic backgrounds of the families. Likewise, differences for families from urban and rural areas and from northern, southern, eastern and western regions, since their foods may vary, need to be known.

If refrigerators, or for that matter any other household appliances or storage areas of the house, are to meet the needs of the people who use them, the needs of these people must be known.

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APPENDIX

EXHIBIT A

THE USE OF REFRIGERATED STORAGE SPACE

1. _____Name.
2. _____Street Address.
3. _____Wife's Occupation.
4. _____Husband's Occupation.
5. _____Yes
   _____No Own home?
6. _____Number adults (18 and over).
7. _____Number children (17 and under).
8. _____Ages of children.

FREEZER

9. _____Yes
   _____No Have or have access to a freezer?

LOCATION

10. _____Room located.
11. _____Next to sink
    _____Next to range
    _____Cabinet space on each side
    _____Cabinet space on right side
    _____Cabinet space on left side
    _____Door opens to the left
    _____Door opens to the right
    _____Alone
12. _____Brand name.
13. _____Number cubic feet, _____Year

MEALS

14. _____Number people for breakfast
    _____Number people for lunch
    _____Number people for dinner

ENTERTAINING

15. _____Number meals per week or month ____No. people
    _____Number snacks per week or month ___No. people
    _____Number drinks per week or month ___No. people

WATER

16. _____Yes
    _____No Store water?
    _____Quantity, summer

MILK

17. _____Yes
    _____No Buy fresh milk
    _____Size containers
    _____Maximum amount stored
    _____Yes
    _____No Supply adequate? _____Amount needed
18. _____Yes
    _____No Use dried milk?
    _____Quantity prepared and stored at one time.

DRINKS

19. _____Maximum amount baby bottles milk, juice and water
20. _____Yes
    _____No Store drinks other than milk and juice?
    _____Small
    _____King
    _____Quart

EXHIBIT A

ICE
21. _____Number trays of ice ____Summer ____Entertaining

SALADS
22. _____Prepare congealed, frozen, mixed or fruit salad?
_____Number per week
_____Number days frozen and congealed salads kept.

LEFT-OVERS
23. _____Covered
_____Uncovered
_____Wrapped Storage left-over meats
24. _____Covered
_____Uncovered
_____Wrapped Storage left-over fruits and vegetables
25. Kinds Left-Overs Amounts No. Days Kept

DEFROST
26. _____Yes
_____No Throw away most left-overs when defrost?
_____Automatic? _____Manual?
27. _____Number times you clean out inside

MEAT
28. _____Method storing fresh meat
_____Length of time fresh meat kept without freezing
_____Fresh meat you find difficult to keep
_____Yes
_____No Would you prefer to keep more fresh meat?
_____Yes
_____No Freeze fresh meat?
_____Quantity frozen per week

VEGETABLES
29. _____Method storing fresh vegetables

PRE-PREPARING
30. _____Yes
_____No
_____Sometimes Prepare meals or parts ahead of time?
_____Freeze some?

CANNED FRUIT
31. _____Yes
_____No Store canned fruit and juice
_____Number cans per week

COVERS
32. _____Yes _____Yes _____Yes
_____No Cover butter____No Cake _____No Liquids

SHOPPING
33. _____Times you grocery shop per week
_____Times you shop for emergency items
_____Yes
_____No Buy items you don't really need?

HEIGHT
34. _____Children
_____Adults Height for storage dependent upon.

SHELVES
35. _____Yes
_____No Practice pulling out or revolving shelves?
_____Why not, if no.

CLOTHES
36. _____Yes _____Refrigerator
_____No
_____Sometimes store clothes to iron? ____Freezer
_____Amount

EXHIBIT A

PROBLEMS 37. _____List special problems in use.

FREEZER 38.
_____Yes
_____No Plan and prepare meals ahead for freezing?
_____Yes
_____No Extra ice cubes stored?
_____Yes
_____No Use Rich Plan or Amana Plan?
_____Yes
_____No Freezer filled seasonally?
_____Yes
_____No Freezer filled with grocery bargains?

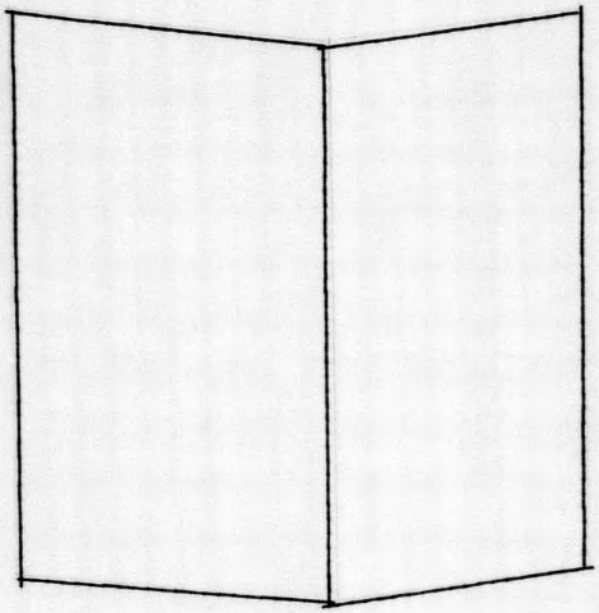
EXHIBIT B

INVENTORY OF REFRIGERATOR

Name of Food	Measurements		
	Height	Depth	Length
FRESH FRUITS			
FRESH VEGETABLES			
FROZEN FRUITS			
FROZEN VEGETABLES			
LIQUIDS			
DAIRY PRODUCTS			
ICE			
FRESH MEATS			
FROZEN MEATS			
ACCOMPANIMENTS			
LEFT-OVERS			

EXHIBIT C

LOCATION OF FOODS
STORED IN REFRIGERATOR



LIST OF FOODS
FOUND IN REFRIGERATOR

1.	21.	41.
2.	22.	42.
3.	23.	43.
4.	24.	44.
5.	25.	45.
6.	26.	46.
7.	27.	47.
8.	28.	48.
9.	29.	49.
10.	30.	50.
11.	31.	51.
12.	32.	52.
13.	33.	53.
14.	34.	54.
15.	35.	55.
16.	36.	56.
17.	37.	57.
18.	38.	58.
19.	39.	59.
20.	40.	60.

EXHIBIT D

FREQUENCY OF USE OF REFRIGERATOR

To be filled out on the day following grocery shopping. In column I list the foods and drinks you and your family remove from the refrigerator each time you open the door. In column II list the amounts of each food and drink used at each time of removal.

Example:

I	II
Milk	½ cup, 1 Qt., 1T.

(Note: You may use the same food several times; therefore, list the food only once, but list the amounts each time.)

FRESH FRUITS — APPLES, ORANGES, LEMONS, GRAPES, GRAPEFRUIT			
FOOD	QUANTITY	FOOD	QUANTITY
FRESH VEGETABLES — BROCCOLI, BEANS, CORN, OKRA, LETTUCE			
FROZEN FRUITS — PEACHES, STRAWBERRIES, RASPBERRIES			
FROZEN VEGETABLES — GREENS, FRENCH FRIES			
LIQUIDS — MILK, FRUIT JUICE, COKES, WATER			
DAIRY PRODUCTS — BUTTER, MARGARINE, EGGS, CHEESE			
FRESH MEATS — HAMBURGER, ROASTS, CANNED MEAT			
FROZEN MEATS — FISH STICKS, CHOPS			
ACCOMPANIMENTS — PICKLES, OLIVES, SALAD DRESSING, MAYONNAISE			
LEFT-OVERS			
ICE, SALADS			
SPECIAL USES — IRONING, COOLING			

EXHIBIT E

A CHI-SQUARE CONTINGENCY TABLE

Family Meals/ Week	Amount Fresh Fruits Cubic Inches		
	77.07 - 388.0	456 - 1756	
Low 74	15 10.26	5 9.74	20
High 74	5 9.74	14 9.25	19
	20	19	39

15 - 10.26 = 4.74 22.47 = 2.19
5 - 9.74 = 4.74 22.47 = 2.307
5 - 9.74 = 4.74 22.47 = 2.307
14 - 9.25 = 4.75 22.56 = 2.438

1% Significant

Formula:

$$Z \frac{(o-e)^2}{e} = \text{Chi square}$$